AMCO2153 Fluvial hydraulics

[45h+30h exercises] 7 credits

This course is taught in the 1st semester

Teacher(s): Sandra Soares Frazao, Yves Zech
Language: French
Level: Second cycle

Aims

Knowledge and understanding of fluvial processes with the aim of designing fluvial works

Main themes

- In-depth knowledge of open-channel hydraulics
- Introduction to free-surface transient flows and numerical hydraulics
- Introduction to morphodynamic flows and to fluvial morphology: sediment transport, density currents and debris flows

Content and teaching methods

- Introduction: field of application of Fluvial Hydraulics, types of rivers, basic elements in morphodynamics (2 hours) ;
- Complements in steady open-channel flows (5 hours)
* Flows in natural rivers: pseudo-uniform flow
* Flow in irregular geometry:
* Flow between a bottom outlet and a reservoir
* Changes in bed slope
* Changes in the channel width and obstacles: bridges and dam piers, Venturi channels, weirs, broad crested weir
* Flow in rivers with floodplains
- Transient free-surface flows (10 hours)
* Shallow-water equations (Saint-Venant), analysis and solution using the characteristics
* Positive and negative waves
* Numerical methods: finite-differences, finite volumes, finite elements, shock capturing methods
* Models for fast or sudden transient flows: flash floods and dam-break flows ; introduction to turbulence modelling
* Extension to 2D models (horizontal plane)
- Sedimentology (12 hours)
* Definitions, general river morphology, bed forms and Exner equation
* Modes of grain transport and vertical structure of flows : types of sediment transport: suspension, collisional and frictional granular contacts, Bagnold's theory for dispersive stresses, types of sediment transport: density currents, dry granular flows, debris flow, fluvial flow: bed load, saltation and suspension ;
* Non-dimensional variables in sedimentology : velocity distribution, mean velocity and friction velocity, non-dimensional analysis and characteristic numbers ;
* Erosion limit of sediment beds: critical velocity criterion: equilibrium profile of a river, critical shear stress criterion: Shields' and van Rijn's diagrams ;
* Bed friction of alluvial rivers and stage-discharge relation: Eisntein's analysis
* Bed load transport:
du Boys principle, Meyer-Peter-Müller analysis, other common approaches (Einstein, Bagnold, etc.) ;
* Suspension transport:
transport equations, concentration distribution (Vanoni-Rouse theory), suspension load (Einstein's integration) ;
- Morphological evolution of rivers (10 hours)
* Sedimentological equilibrium of a river: practical formulae: sedimentological regime, bank resistance to erosion, profile of equally distributed resistance to erosion ;
* Morphological response to fluvial works: feeding by local sediment supply, local widening and constrictions, canalisation and clear water derivation, influence of a tributaries, local erosion: bridge piers, downstream side of weirs ;
* Principles of river training: secondary helical currents, Fargue's laws and rules, local works: surface panels, bandalls, bottom panels, amelioration of weirs and bends, bank protection, river training: principles of Fargue and Girardon ;
* Numerical models in fluvial morphology: notion of non-equilibrium and transport models, morphological models in equilibrium and non-equilibrium: equilibrium profile, nick point, dam-break on mobile bed ;
- Other modes of sediment transport in fluvial and torrential hydraulics (6 hours)
* Density and turbidity currents
* Debris flows: avalanches and torrential lava flows
* Transport of pollutants in rivers: mixing mechanisms and turbulent flows, vertical and transversal diffusion, longitudinal dispersion

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

- Complementary topic of the theme "Hydraulics"
- Prerequisite: AMCO 2152 "Hydraulics"
- Pedagogy: mix of lectures, practical and lab work-
- Evaluation: Exercise examination at the end of the semester (20% of total); transient flow computer programme during the year (20% of total); oral examination (60% of total)
- Support: syllabus

Other credits in programs

GC22	Deuxième année du programme conduisant au grade d'ingénieur civil des constructions	(7 credits)
GC23	Troisième année du programme conduisant au grade d'ingénieur civil des constructions	(7 credits)